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# Computed tomographic localization of the deepest portion of the femoral trochlear groove in healthy dogs

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Abstract: Objective: To validate a computed tomographic (CT) method to measure the femoral trochlear groove depth (FTGD). Study design: Cadaveric study. Sample population: Fifteen dogs, 26 femoral trochleae. Methods: Five points were identified from proximal to distal (proximal point [PP], P25, P50, P75, and distal point [DP]) along the trochlea via three-dimensional volume-rendering function on the sagittal plane and measured on multiplanar reconstruction images. Each rater repeated measurements in duplicate, unaware of the identity of the joint. The FTGD was quantitated on the anatomical specimens and statistically compared with CT measurements. Intrarater and interrater agreements were analyzed by using intraclass coefficients. Accuracy was evaluated by using either adjusted R2 coefficients (R2 > 80% was considered acceptable) or Student's t test. The ratio of the patellar and the trochlear width and the ratio of the patellar craniocaudal thickness inside the trochlear groove were calculated at three different patellar locations. Results: Good to excellent intrarater and interrater agreements were observed in four of five trochlear points (P25, P50, P75, and DP), and accuracy was acceptable for these points (R2 > 80%). Computed tomographic measurements differed from the mean anatomical measurements at three of five points (PP, P50, and P75; P < .01), overestimating the FTGD by an overall mean of 0.18 mm (range, 0.02-0.3). P25 and P50 were the deepest points measured. Conclusion: Computed tomography allowed precise measurements of trochlear groove depth except for the most proximal point. The deepest trochlear points were P25 and P50. P25 was the most precise and accurate point measured, while PP was the least consistent. Clinical significance: The deepest portion of the trochlea groove may be located between P25 and P50. Evaluation of this CT method in dogs with patellar luxation is recommended.

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# The deepest portion of the femoral trochlear groove is located on its proximal aspect in a group of healthy dogs.

**A CT methodology to measure the femoral trochlear groove depth.**

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ABSTRACT

**Objectives:** To validate a computed tomographic (CT) methodology for the measurement of the femoral trochlear groove depth (FTGD). Intra-rater/inter-rater agreements and accuracy were assessed.

**Study design:** Ex-vivo cadaveric study.

**Sample population**: Fifteen dogs, 26 femoral trochleae.

**Materials:** Five trochlear points, from proximal to distal (PP, P25, P50, P75, and DP) were identified through three dimensional-volume-rendering function on the sagittal plane and measured on multiplanar reconstruction images. Each rater blindly performed the measurements in duplicate**.** The FTGD was quantified on the anatomical specimens and statistically compared with CT measurements. Intra-rater and inter-rater agreements were analyzed using intra-class coefficients (ICCs). Accuracy was evaluated using either adjusted $R^2$ coefficients ($R^2$> 80% was considered acceptable) or the student t-test. The ratio of the patellar and the trochlear width and the ratio of the patellar craniocaudal thickness inside the trochlear groove were calculated at three different patellar locations.

**Results:** Good to excellent intra-rater and inter-rater agreements were observed resulted in four out of five trochlear points (P25, P50, P75, and DP) and accuracy was acceptable for these points ($R^2$>80%). Statistically significant difference (P<0.5) was observed between mean CT measurements and mean anatomical measurements at three points (PP, P50 and P75). P25 and P50 were the deepest points measured respectively.

**Conclusions:** The CT methodology was precise for measuring the trochlear groove depth except for the most proximal point. The deepest trochlear points were P25 and P50. P25 was the most precise and accurate point measured, while PP was the most inconsistent.

**Clinical relevance:** The region between P25 and P50 might be the site where the trochlear grove is the deepest. A clinical study using the same CT methodology in dogs affected by patellar luxation is recommended.

## INTRODUCTION

Patellar luxation is one of the most common canine orthopedic diseases of the hindlimb.[1,2] Several surgical techniques, including trochleoplasty,[3,4] were reported to manage patellar luxation.[5-8] Evaluation of the femoral trochlear groove depth (FTGD) is necessary to estimate whether the groove needs to be deepened to better accommodate the patella.[3,4,9-12] Several diagnostic techniques have been described to assess the FTGD. These include radiographs,[13,14] computed tomography (CT),[15,16] magnetic resonance imaging (MRI),[17] and recently ultrasonography (US).[18,19] Ultrasound is non-invasive diagnostic technique. It is advantageous when compared with other imaging techniques, as it does not usually require patient sedation. However, reliability of US is affected by its operator-dependency.[20] CT-scans can be performed in dogs affected by patellar luxation for evaluation of limb deformity evaluation.[21,22] A previous report investigated the FTGD with a consistent CT protocol.[16] The ratio of maximal patellar thickness and maximal trochlear depth ratio was assessed.[16] However, the precision and the accuracy of FTGD measurements at in different trochlear positions were not assessed. Moreover, to the best of authors' knowledge, little is known relative to the location of the deepest point of the femoral trochlea.

The objective of this study is threefold: 1) describe a CT methodology for measurement of the FTGD at five trochlear positions; 2) investigate the precision and the accuracy of CT in the measurement of FTGD; and 3) calculate the ratio of the patellar width and the trochlear width and the ratio of the patellar craniocaudal thickness inside the trochlear groove.

The starting hypotheses were: 1) the proposed CT methodology is precise (good to excellent intra-rater and inter-rater agreements); 2) CT FTGD measurement is accurate (no difference between anatomical and tomographic FTGD measurements); and 3) the ratio of patellar width and trochlear width is < 1 at all the measured points and the ratio of patellar craniocaudal thickness inside the trochlear groove is < 0.5.

METHODS:

Thirty hindlimbs were collected from adult client-owned dogs euthanized for reasons unrelated to the present study. The specimens were collected according to directives of our institution after signed informed consents were obtained from the owners. A gross physical examination was performed followed by a radiographic survey to rule out hindlimb deformities, patellar luxation, or evidence of degenerative joint disease of the stifle. Femurs with radiographic abnormalities were excluded from the study. Breed, sex, age, and weight were recorded.

*CT evaluation*

The cadavers were placed on a foam cradle in a supine position with the pelvic limbs extended and slightly adducted. The required positioning was obtained by tying the limbs with medicated gauzes. The stifle joints were positioned at a predetermined angle (range: 130°-140°).[23] Imaging was performed using a 4-multi-detector-row CT scanner (*Toshiba Asteion S4*, Toshiba Medical Systems Europe, Zoetermeer, Netherlands) in helical acquisition mode, using a slice thickness of 1 mm (reconstruction interval: 0.8 mm). CT images were reconstructed with a high-resolution filter for bones and subsequently, with a commercially available DICOM processing software (*Osirix, Version 5.8, Pixmeo SARL, Bernex, Switzerland).*

Each rater blindly performed the measurements in duplicate. The five trochlear positions were identified as follows:

1- Three-dimensional (3D)-volume-rendering function was selected. The femur was isolated with the cropping function and positioned in the sagittal plane and in the lateral view, with the superimposition of the two femoral condyles.

2- Two points were initially identified: a proximal point (PP) was marked on the proximal aspect of the lateral trochlear ridge and a distal point (DP) was identified at the proximal aspect of the extensor fossa (*sulcus extensorius*) (Figure 1A).

3- An osculating circle matching the lateral femoral trochlear ridge and passing through PP and DP was drawn (Figure 1A).

4- Two lines connecting PP and DP to the center (ô) were drawn. The angle PP-ô-DP was measured (Figure 1B).

5- The angle was subdivided into four equal angles. The arc from PP to DP was so divided into four arc cords (Figure 1C). Three additional points were thus identified onto the lateral femoral trochlear ridge (P25, P50, and P75) (Figure 1C).

6- The 3D curved-multiplanar reconstruction function (MPR) was selected.

7- The sagittal reconstructed images were scrolled until the target trochlear points were sequentially visualized. The lateral trochlear ridge was superimposed on an osculating circle (Figure 1D). The vertical axis of the Bezier path was positioned tangentially to the circle for each point (Figure 1D depicts the measurement for P50).

8- The MPR transverse view was selected (Figure 1E). The trochlear joint orientation line (line *a* Figure 1E) in the transverse plane was drawn, passing through the two most prominent points on the trochlear ridges.

9- A segment perpendicular to line *a*, connecting the deepest point of the trochlear groove to line *a* was drawn and measured (Figure 1F).

The trochlear and the patellar widths as well as the portion of the patellar craniocaudal thickness inside the trochlear groove were measured as follows:

1- In the MPR sagittal view, the sagittal patellar maximal length was measured, and three perpendicular lines were drawn at 25%, 50%, and 75% of the sagittal patellar length (Figure 2A). The vertical axis of the Bezier path was then sequentially superimposed on each selected line (Figure 2A).
2- The transverse view was selected (Figure 2B). The distance between the two most prominent points on the trochlear ridge was measured on the trochlear orientation line (trochlear width) (Figure 2B).
3- The distance from the trochlear joint orientation line and the most caudal patellar point was measured (red segment, Figure 2C).
4- The segment perpendicular to the trochlear orientation line, connecting the deepest point of the trochlear groove to the joint orientation line was measured (yellow segment, Figure 2C).
5- Two half-lines perpendicular to the horizontal axis of the Bezier path were drawn to delimitate the patellar width. Patellar width and craniocaudal thickness were then measured (red segment and yellow segment, respectively) (Figure 2D).
6- This procedure was repeated for all three selected lines (25%, 50%, and 75%).

*Anatomic evaluation*

The femurs were fully disarticulated. They were stored at -18° C and thawed at room temperature for 24 hours before the measurements.

A single rater performed the measurements on the femoral trochlear specimens in duplicate.

1- The PP and DP were identified on the lateral trochlear ridge, following the same CT procedure (Figure 3A). The other three points (P25, P50 and P75) were localized using a tailor ruler (Figure 3B).
2- The depth-measuring probe of the caliper was placed at the midpoint of the trochlear ridges to measure the trochlear groove depth at each of the five target trochlear points (Figure 3C).

*Collection of the measured data*

Research Randomizer version 4.01 (Social Psychology Network, PA, USA) was used to randomize the samples. Data was collected using a spreadsheet software (Microsoft Excel, Version 16.0, Microsoft Corp., WA, USA). The patellar-trochlear width was defined as the ratio of the patellar width and the trochlear width. The value 0 denoted that the patella was absent and the value 1 meant that the patella was as wide as the trochlea. The intra-trochlear patellar ratio was expressed as the patellar craniocaudal thickness contained within the trochlear groove.

*Statistical analysis*

Statistical analysis was performed using two software packages (MedCalc Statistical Software version 17.3; MedCalc Software Ltd., Ostend, Belgium and SAS 9.4, SAS Institute Inc., Cary, NC, USA).

Minimum sample size was calculated using a method based on the estimation of a confidence interval with the required width.[24] Data was used from a preliminary analysis, in which the difference between the observed (anatomical record) and the measured values (with the three methods) was calculated. The averages and the standard deviations were 0.51±0.43, 0.37±0.34, and 0.24±0.18 for PP, M, and PP3 respectively. At least 25 values were enough for a type I error of 0.05 and a power of 90%.

The descriptive statistics (means, standard deviations and medians) were calculated for each trochlear point for both CT protocol and anatomic measurements. Data normality was assessed using the Shapiro-Wilks test. Mixed model analysis of variance was used with animal as the random effect and trochlear points as the fixed effect. Statistical significance was set a P-value $<$ 0.05 based on a two tailed assumption. Precision was defined as the variation in the outcomes obtained on repeated testing of the same sample group by multiple raters (intra-rater and inter-rater agreements).[21] The accuracy of the tested methodology was defined by how close the measured value was to an assumed true value, which had to be either identifiable or measurable. We have considered the anatomical measurements as the gold standard for the assessment of bone measurements.[25,26]

The intra-rater and inter-rater intra-class coefficients (ICCs) with 95% confidence intervals (95% CI) were assessed. The ICC score ranged from 0 (no agreement) to 1 (perfect agreement). An agreement was defined poor for ICC<0.8, good for 0.8< ICC<0.9, and excellent for ICC>0.9.[27,28]

The accuracy of the measurements was investigated through the adjusted $R^2$ to evaluate the strength of the relationship between the angle measured through CT (tested methodology) and the angle measured through anatomical measurements. Adjusted $R^2$ values > 80 % were considered acceptable.[25,29] The hypotheses of the linear model on the residuals were graphically assessed.

Paired Student t-test was used to assess the difference between the averages of the CT data the averages of the data collected through the anatomical methods. The comparisons of the averages of the CT measurements were also assessed for every trochlear point.

## RESULTS

Thirty trochleae were initially included. Four trochleae were excluded from the study as the gross evaluation of the specimens and radiographs showed the presence of degenerative joint disease. Thus, twenty-six femoral trochleae obtained from 15 dogs were included. Nine females and 6 males constituted the sample. Canine cadavers ranged in body mass from 5.5 kg to 42 kg (mean: 21.3 kg; median: 26 kg). The ages range from 3.2 years to 11.5 years (mean: 7.7 years, median: 8 years). The Labrador Retriever was the most common breed (4 dogs). The other breeds included: 3 German Shepherds, 3 mixed-breed dogs, 2 Rottweilers, 1 Cane Corso, 1 English Setter and 1 Pug.

Means, standard deviations, and medians of the FTGD measured at the level of the five trochlear points are listed in Table 1.

The P25 was the deepest point of the trochlear groove among the target trochlear points, while the PP was the most superficial point (Table 1). The means of patellar craniocaudal thicknesses measured at the designated patellar length positions (25 %, 50%, and 75% of the sagittal patellar length) are displayed in Table 2. Patella was thicker between 50% and 75% of its sagittal length. The ratios of the mean patellar widths and the trochlear widths are presented in Table 3. The ratios of the patellar craniocaudal thicknesses inside the trochlear groove and the total patellar craniocaudal thicknesses are also displayed in Table 3. Good to excellent intra-rater and inter-rater agreements were observed for P25, P50, P75 and DP, while PP was found to be inconsistent (Table 4). Intra-rater and inter-observers ICCs for P25 and P50 were > 0.9 (0.95<ICCs<0.98). ICCs for P75 and DP were good to excellent (0.88<ICCs<0.93) in terms of intra-rater agreement and excellent in terms of inter-rater agreement (≥ 0.9). The ICCs for PP were fair (ICCs < 0.8) either for intra-rater and inter-rater agreements (Table 2).

Regarding the accuracy evaluation, the adjusted $R^2$ value for the comparison between CT and anatomical measurements showed that P25, P50, P75, and DP had a $R^2 > 80\%$. The overall coefficients are displayed in Table 5. P25 was the most accurate point measured ($R^2$=0.85), while PP was the only inaccurate point ($R^2$=0.49). Results of the paired Student t-test showed that there were not a statistically significant differences (P > 0.05) between mean CT measurements and mean anatomical measurements at 2 out of 5 points (P25 and DP) (Table 5), whereas mean CT measurements at PP, P50, and P75 were significantly different from those measured directly on the trochleae specimens (P< 0.01). Paired Student t-test also highlighted that there were not a statistically significant differences among the mean measurements by observers at P25, P50, and P75 points (P > 0.05) (Table 5). An observer effect was found for PP and DP (P < 0.05).

## DISCUSSION

The results showed that the CT measurement of FTGD was precise at P25, P50, P75, and DP (Table 1). Therefore, we accept our first hypothesis, providing evidence about the consistency and the precision of the proposed methodology at 4 out of 5 points. Specifically, P25 and P50 were the most precise points with respect to the FTGD measurement (ICCs > 0.95) in healthy dogs without patellar luxation. This finding may imply that these points are associated with high consistency for the FTGD measurement. Hence, they possibly represent the most reliable trochlear locations where to evaluate the FTGD through CT. However, a clinical investigation in dogs affected by patella luxation is needed to be validate these results.

The CT measurements were reasonably accurate, as the adjusted $R^2$ values were above the acceptance criterion of 80% at 4 out of 5 target trochlear points. This finding suggests that the CT measurements were similar to the anatomical measurements (except at PP) and thus they may be considered accurate. However, we partially reject our second hypothesis, as the paired Student t-test highlighted a statistically significant difference between the mean CT measurements and the mean anatomical measurements at 3 out of 5 points (PP, P50, and P75). In detail, CT measurements were found to be overestimating the FTGD by an overall mean of 0.18 mm (range: 0.02-0.3 mm). Recently, an US approach to assess the FTGD has been proposed. [19] US measurements were compared with intraoperative evaluation of the FTGD.[19] Although, the two approaches showed agreement, Hansen et al. concluded that US was not able to predict the FTGD correctly.[19] The aim of the present study was to assess a CT methodology for the preoperative evaluation of the FTGD. Similar to US, CT measurements could be also affected by the skill of the operator.[20,30,31] However, it is not such a dynamic evaluation to be susceptible to interpretative errors.[20] Moreover, CT-scan allows for free manipulation of the 3D reconstructed images, where specific target landmarks may be identified.[21] Furthermore, the 3D-curved MPR viewer option provided by the DICOM processing software offers three views of the same object in three orthogonal planes, each in relation with the others.[32] The intersection between the vertical and the horizontal axes (the 3D Bezier path) allows the user to move around the region of interest (ROI) and obtain three perpendicular views by rotating on it.[32] In our protocol, the vertical axis of the 3D Bezier path was constantly positioned tangentially to the circle drawn matching the curvature of the lateral trochlear femoral ridge to avoid operator-dependent errors while measuring the groove depth. Indeed, the FTGD measurement is influenced by the position of the mentioned axis relative to the femoral trochlear ridge in the sagittal plane (Figure 4).

Based on our results, we discourage the measurement of the FTGD in a position that is too proximal, since the PP was the most inconsistent and unreliable point to be measured and also the shallowest point of the trochlear groove (Tables 1, 4, and 5). Some anatomical details may partially explain the inconsistency in measurement associated with PP. Finding the exact position of the most proximal point of the lateral femoral trochlear ridge was sometimes difficult due to the lack of a clear anatomical landmark such as the extensor fossa for the DP in the proximolateral region of the femoral trochlea. Moreover, the anatomical conformational differences between the proximal portion of the medial and the lateral trochlear ridges may have contributed to increased errors during the measurements of the FTGD in PP in either CT or the anatomical measurements. The femoral trochlear ridges diverge proximally and may have a different profile in the proximal trochlea.[33,34] Therefore, the incorrect positioning of the line tangential to the trochlear ridges (CT scans) or the caliper on the tops of both the femoral trochlear ridges (anatomical measurements) could be a plausible explanations for the inconsistent FTGD measurement at PP. Additionally, we cannot exclude the possibility that subjective variables such as breed and age might have affected the FTGD measurement at PP.

The trochlear depth is influenced by the frequency of patellar tracking during the skeletal development.[33,35] In the present study, we found out that the deepest trochlear point (P25) was located in the proximal part of the femoral trochlea, midway between the proximal aspect of the lateral trochlear ridge and at 50% of the sagittal trochlear length (Figure 1B). There was a mean difference of 0.5 mm in the measurements at the second deepest point (P50) and a mean difference of 1.7 mm in the measurements at the shallowest point (PP). Reasonably, we can speculate that patella tracks more frequently between P25 and P50, and therefore this position can be considered the reference point to evaluate FTGD.

We accept our third hypothesis as we found out that the patellar-trochlear width ratio was $< 1$ at all three selected patellar areas. Mean patellar-trochlear width measurement showed a gradual increase from 74% to 86% in the patellar width relative to the trochlear width from the proximal direction to the distal direction, respectively (Table 3). We also found that that the major patellar craniocaudal thickness was located on the distal half of the patella (Table 2). Moreover, the ratio of patellar craniocaudal thickness inside the trochlear groove was always under 0.5. The insertion of the patella in the trochlear groove was the most pronounced at 50% of its sagittal length (Table 3). Therefore, this patellar region should be considered while evaluating the proportion between patella and trochlear groove.

Our findings should be interpreted in light of some limitations. It was an ex vivo study which investigated normal hind limbs in normally developed trochleae. Dogs affected by patellar luxation frequently show degenerative changes that can affect CT measurements. Thus, the present study may not answer whether these changes could have a direct impact on the study outcome in a clinical setting involving dogs with pathologies. We included a heterogeneous group of dogs, and no standardization was performed with respect to breed and size. Hence, we could not provide any reference range for individual breeds. We also found overestimation of the FTGD in the CT measurements. This overestimation may be due to the inability of CT to accurately detect the cartilage thickness as accurately as MRI[17]or US[19], resulting in a small proportions of errors.

In conclusion, the main outcomes of this study suggest that 1) the proposed CT methodology was precise at 4 out of 5 points and was sufficiently accurate at some points considered, barring a slight FTGD overestimation has to be pondered; 2) P25 was the most reliable (precise and accurate) point for the measurement of the FTGD and it was also the deepest point of the femoral trochlear groove. One of the main potential benefits of using this CT methodology could be its reliability in preoperative evaluation of the FTGD. Before its clinical application, a prospective clinical study is recommended to validate this methodology in dogs affected by patellar luxation.

DISCLOSURE

None of the authors of this paper have a financial or personal relationship with other people or organizations that could inappropriately influence the content of this study.

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FIGURE LEGENDS

Figure 1: CT measurement of femoral trochlear groove depth (FTGD) at five trochlear points. A proximal (PP) and distal point (DP) were found in a three dimensional (3D)-volume rendering sagittal view of the femoral lateral trochlea (A). The lateral femoral condyle was fitted with an osculating circle. Two lines connecting PP and DP to the osculating circle center ((ô) were drawn. Measurement of the angle (B). Four equal angles were calculated, and three additional trochlear points were marked (P25, P50, and P75) (C). Images D, E, F depict the curved-multiplanar reconstruction (MPR) measurement of the FTGD at P50: a circle was drawn in the MPR sagittal view to superimpose the lateral femoral trochlear ridge. The vertical axis of the Bezier path was positioned tangentially to P50 (D). On the MPR transverse image, a joint orientation line connecting the most proximal trochlear ridge points was drawn (line a) (F). The FTGD was measured at the midpoint of line a (yellow line).

Figure 2: Measurement of patellar/trochlear width and of the patellar craniocaudal thickness inside the groove. In the sagittal curved-multiplanar reconstruction (MPR) view, the vertical axis of the Bezier path was positioned across the most proximal and distal patellar edges (blue line). The patellar sagittal length was measured (A). Three perpendicular lines to the vertical axis of the Bezier path were drawn: 25%, 50%, and 75% of the patellar sagittal length. The horizontal axis of the Bezier path was aligned sequentially with each line. The joint orientation line connecting the most proximal trochlear ridge points was measured (green segment) to define trochlear width (B). The distance from the trochlear joint orientation line and the most caudal patellar point was measured (C, red segment). A segment perpendicular to the trochlear orientation line, connecting

the deepest aspect of the trochlear groove to the joint orientation line was measured (yellow segment) (C). Two lines parallel to the vertical axis of the Bezier path were drawn (green lines) (D). The patellar width (yellow line) and patellar craniocaudal thickness (red line) were measured.

Figure 3: Anatomic measurement of the FTGD. The PP and DP were marked on the lateral trochlear ridge (A). Three additional points were localized using a tailor ruler (B). The depth-measuring probe of the caliper was positioned at the midpoint of the trochlear ridges to measure the FTGD (C). The procedure was repeated for every trochlear point.

Figure 4: 3D curved-multiplanar reconstruction (MPR) for the measuring of FTGD. Colum A shows the positioning of the vertical axis of the Bezier path across the target point and tangent to the osculating circle in the sagittal view (upper line). In the traverse view (lower line), the image shows the FTGD measurement. In column B and C, the same procedure is repeated; however, the modification of the orientation of the vertical axis leads to a different FTGD measurement.

Table 1 Descriptive statistics for the measurement of the femoral trochlear groove depth (FTGD) for each femoral trochlear point.

| FTGD (mm) | | PP | P25 | P50 | P75 | DP |
|---|---|---|---|---|---|---|
| Rater 1 | Mean ± SD | 1.39 ± 0.48 | 3.31 ± 0.9 | 2.79 ± 0.9 | 2.41 ± 0.8 | 1.93 ± 0.68 |
| | Median | 1.55 | 3.35 | 3.15 | 2.45 | 2.0 |
| Rater 2 | Mean ± SD | 1.81 ± 0.59 | 3.2 ± 0.9 | 2.69 ± 0.8 | 2.34 ± 0.7 | 2.17 ± 0.62 |
| | Median | 1.75 | 3.3 | 2.7 | 2.3 | 2.05 |
| Rater [1,2] | Mean ± SD | 1.39 ± 0.48 | 3.31 ± 0.9 | 2.79 ± 0.9 | 2.41 ± 0.8 | 1.93 ± 0.68 |
| | Median | 1.55 | 3.35 | 3.15 | 2.45 | 2.0 |

Table 2 Descriptive statistics for the measurement of the patellar craniocaudal thickness at the 25%, 50% and 75% of patellar length (PL) calculated.

| Patellar thickness (mm) | | 25% PL | 50% PL | 75% PL |
|---|---|---|---|---|
| Rater 1 | Mean ± SD | 7.89 ± 2.00 | 8.59 ± 2.3 | 8.54 ± 2.53 |
| | Median | 8.3 | 9.2 | 8.75 |
| Rater 2 | Mean ±SD | 8.03 ± 2.1 | 8.68 ± 2.21 | 8.55 ± 2.33 |
| | Median | 8.2 | 9.25 | 8.9 |
| Rater [1,2] | Mean ± SD | 7.9 ± 2.03 | 8.63 ± 2.29 | 8.54 ± 2.44 |
| | Median | 8.31 | 9.2 | 8.95 |

Table 3 Means of patellar-trochlear width ratio and ratio of patellar craniocaudal thickness inside the trochlear groove calculated at the 25%, 50% and 75% of patellar length (PL).

| Mean rater $_{1,2}$ ratios | 25% | 50% | 75% |
|---|---|---|---|
| Patellar-trochlear width | 0.74 | 0.82 | 0.86 |
| Patellar intra-trochlear | 0.2 | 0.3 | 0.27 |

Table 4; Intra-rater and inter-rater intra-class correlation coefficients (ICC) calculated for both observers for each femoral trochlear point.

| Rater | PP | P25 | P50 | P75 | DP |
|---|---|---|---|---|---|
| | **Intra-rat. ICC (95% CI)** | **Intra-rat. ICC (95% CI)** | **Intra-rat. ICC (95% CI)** | **Intra-rat. ICC (95% CI)** | **Intra-rat. ICC (95% CI)** |
| 1 | 0.72 (0.48-0.87) | 0.97 (0.93-0.98) | 0.97 (0.93-0.98) | 0.89 (0.78-0.95) | 0.88 (0.76-0.94) |
| 2 | 0.75 (0.52-0.88) | 0.95 (0.91-0.98) | 0.96 (0.90.98) | 0.93 (0.84-0.96) | 0.91 (0.81-0.96) |

| **Inter-rat$_{1,2}$ ICC** | 0.68 (0.35-0.87) | 0.97 (0.93-0.98) | 0.98 (0.95-0.99) | 0.98 (0.97-0.99) | 0.9 (0.75-0.96) |
|---|---|---|---|---|---|

95% CI :95% confidence interval.

Table 5 Adjusted $R^2$ coefficients and mean difference and P-values of paired t-test calculated for the average comparisons between CT and anatomic measurements.

| Rater$_{1,2}$ CT vs Anatomic | | PP | P25 | P50 | P75 | DP |
|---|---|---|---|---|---|---|
| $R^2$ | | 49% | 85% | 80% | 84% | 83% |
| T- test | Mean ± SD | -0.33 ± 0.46 | -0.08 ± 0.2 | -0.19 ± 0.3 | -0.3 mm ± 0.2 | -0.02 mm ± 0.2 |
| | P-value | <0.001 | 0.22 | 0.01 | <0.001 | 0.6 |